8.—Remains of Potorous platyops (Marsupialia, Macropodidae) and other mammals from Bremer Bay, Western Australia

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Abstract

Mammal remains, probably derived from disintegrated pellets regurgitated by an owl, are described from sand dunes at Bremer Bay. Murid bones from this sample have been dated at 1190 ± 80 radiocarbon years B.P. (GaK-2887). The sample includes remains of the small rat kangaroo *Potorous platyops*, and other remains of this little known species are discussed. A radiocarbon date of 620 ± 90 years B.P. (GaK-2888) on dead wood from the site, taken in conjunction with the bone date and with the present condition of the site suggests that devegetation of the area, presumably by wind blown sand, has extended over more than a thousand years.

Introduction

In March 1970, W. H. Butler collected a small sample of bones from what appeared to be the dispersed remains of owl pellets at Bremer Bay, and presented them to the Western Australian Museum. Remains of two little known marsupials, *Potorous platyops* and *Antechinus apicalis*, were recognized in this sample, and both authors visited the site later in the same month in order to make further collections and field observations.

We follow the nomenclature of Ride (1970), including his use of *Potorous tridactylus* for the populations formerly known as *P. gilberti*. The catalogue numbers quoted represent specimens in the Western Australian Museum collection.

The Bremer Bay site

About 4½ km north east of the old telegraph station at Bremer Bay, the channel of the Hunter River is blocked by sand drift about 1 km inland from the coast. Extensive dunes of mobile sand lie south west of this blocked river channel, and these mobile dunes at present appear to be encroaching on low vegetated dunes west of the channel of the Hunter River. About central in the mobile dunes, bones lay unevenly scattered in an area about 200 m long in a north to south direction and about 250 m long east to west. The site is at 239753 on the Bremer Bay sheet (SI 50-12) of the Australia 1: 250,000 series of maps, lat. 34°22'S, long. 119°24'E.

Bones representing more than 650 animals were recovered from the 200 x 250 m zone, lying on bare sandy surfaces. Only about 10 animals were represented by bones collected on similar surfaces of the remainder of the mobile dune area, about 1 km x 1 km in extent.

Within the 200 x 250 m zone relatively rich in bone, local concentrations were evident, five such local concentrations accounting for more than 600 of the animals represented. Our collection from the principal one of these local concentrations, about 5 x 20 m in extent, represented nearly 500 animals. We did not recover every piece of bone exposed at the surface of the 200 x 250 m area, and our recovery rate varied from place to place, being higher in the local concentrations. We estimate that more than 700 but less than 1,000 animals of various sizes were represented by bony remains within the 200 x 250 m bone rich zone.

Remains of dead trees and shrubs were represented at all the sites of bone concentration mentioned above, some of them upright in the position of growth, but more lying scattered on the sandy surface. The largest of these plant remains is shown in Fig. 1. This represents a fallen tree in which roots and branches were clearly distinguishable, showing that the tree extended at least 7 m above the ground. A comparison was made of wood from this fallen tree with wood specimens from peppermint and eucalypt trees growing nearby. This comparison, kindly made for us by Mr H. D. Ingle of the C.S.I.R.O. Division of Forest Products, Melbourne, showed that the fallen tree was peppermint (*Agonis* cf. *A. flexuosa*) rather than eucalypt.

Fig. 1 also shows (top left) a tree stump in the growth position; not more than 1 m thickness of sand or soil has been removed by deflation from round the roots of this tree. The principal bone concentration, representing nearly 500 animals, lay to the left of the large fallen tree shown in Fig. 1.

Many bones and most tree trunks showed signs of sand blasting or corrosion, but most bones, especially of the smaller mammals (of about the size of a rabbit or less), were unbroken, save that skulls usually had come apart at the sutures.

Thickets of swamp yate (*Eucalyptus occidentalis*), peppermint (*Agonis flexuosa*) and other small trees occupied the banks of the Hunter River, but the vegetation otherwise consisted primarily of shrubby plants.

Weather data are available for the nearby township of Bremer Bay, which has an average annual rainfall of about 620 mm, with a marked maximum in winter (June average 91 mm, January average 14 mm). The mean minimum temperature for July, the coldest month of the year

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Figure 1.—Fallen peppermint tree near principal local accumulation of bone, Bremer Bay. The bow saw is propped against a branch of this tree, partly buried by sand; the roots of the tree are in the foreground. The tree has fallen uphill away from the sea, presumably in the direction of the strongest winds; it lived over 600 years ago. Note stump in growth position on sky line, top left.

is about 8°C, and the mean maximum temperature for February, the hottest month, is about 24°C (Director of Meteorology 1962). Winds are frequent and strong, predominantly from the south west, but often with an easterly component in summer.

Animals represented

Most of the animals represented in our bone collection—about 540 in a total of about 650—were murids. A few other eutherian species, dasyurid, peramelid and phalangeroid marsupials, reptiles, amphibians and fish were represented by bones, while shells of the land snail *Bothriembryon* were prominent among invertebrate remains.

The following mammal species were present:

Murids

Rattus fuscipes	—e.g. 70.3.40
Pseudomys shortridgei	—e.g. 70.4.61
Pseudomys albocinereus	—e.g. 70.4.114
Notomys cf. *N. mitchellii*	—e.g. 70.4.10

Other eutherians

Bat, not specifically identified—	70.4.48
Oryctolagus cuniculus	—e.g. 70.4.43
Ovis aries	— 70.4.155
Canis familiaris	— 70.3.59
Vulpes vulpes	— 70.4.167

Marsupials

Dasyurus geoffroii	—e.g. 70.3.58
Antechinus apicalis	—e.g. 70.4.98
Antechinus flavipes	—e.g. 70.4.103
Sminthopsis murina	—e.g. 70.4.106
Isoodon obesulus	—e.g. 70.4.91
Perameles cf. *P. bougainville*	—e.g. 70.3.15
Pseudocheirus peregrinus	—e.g. 70.3.29
Potorous platyops	—e.g. 70.4.66
Bettongia penicillata	—e.g. 70.4.1
Macropus eugenii	—e.g. 70.3.61
Macropus irma	—e.g. 70.3.28
Macropus (probably *fuliginosus*)	—e.g. 70.3.60

The whole collection from this locality is included under the catalogue numbers 70.3.12 to 70.3.21, 70.3.28 to 70.3.70 and 70.4.1 to 70.4.197.

Potorous platyops

According to Glauert (1950), one or more specimens of this species were obtained from a locality not recorded in the south west of Western Australia by L. Preiss about 1839, but the name *Hypsiprymnus platyops* was conferred by Gould (1844) on a specimen obtained by John Gilbert probably in the Goomalling district (Calaby 1954).

According to Thomas (1888), Gilbert also obtained a specimen in the Albany district, and according to Glauert (1950), G. Masters obtained four specimens in the King George's Sound to Pallinup (Salt) River district between 1866 and 1869. Five specimens from unknown localities in Western Australia reached the National Museum of Victoria in 1874 and 1875 (Ride 1970). Glauert (1933) recorded a specimen from the Margaret River district in the extreme south west of Western Australia, but this record is believed to be erroneous (Ride 1970), and Glauert did not repeat it in his later paper (Glauert 1950).

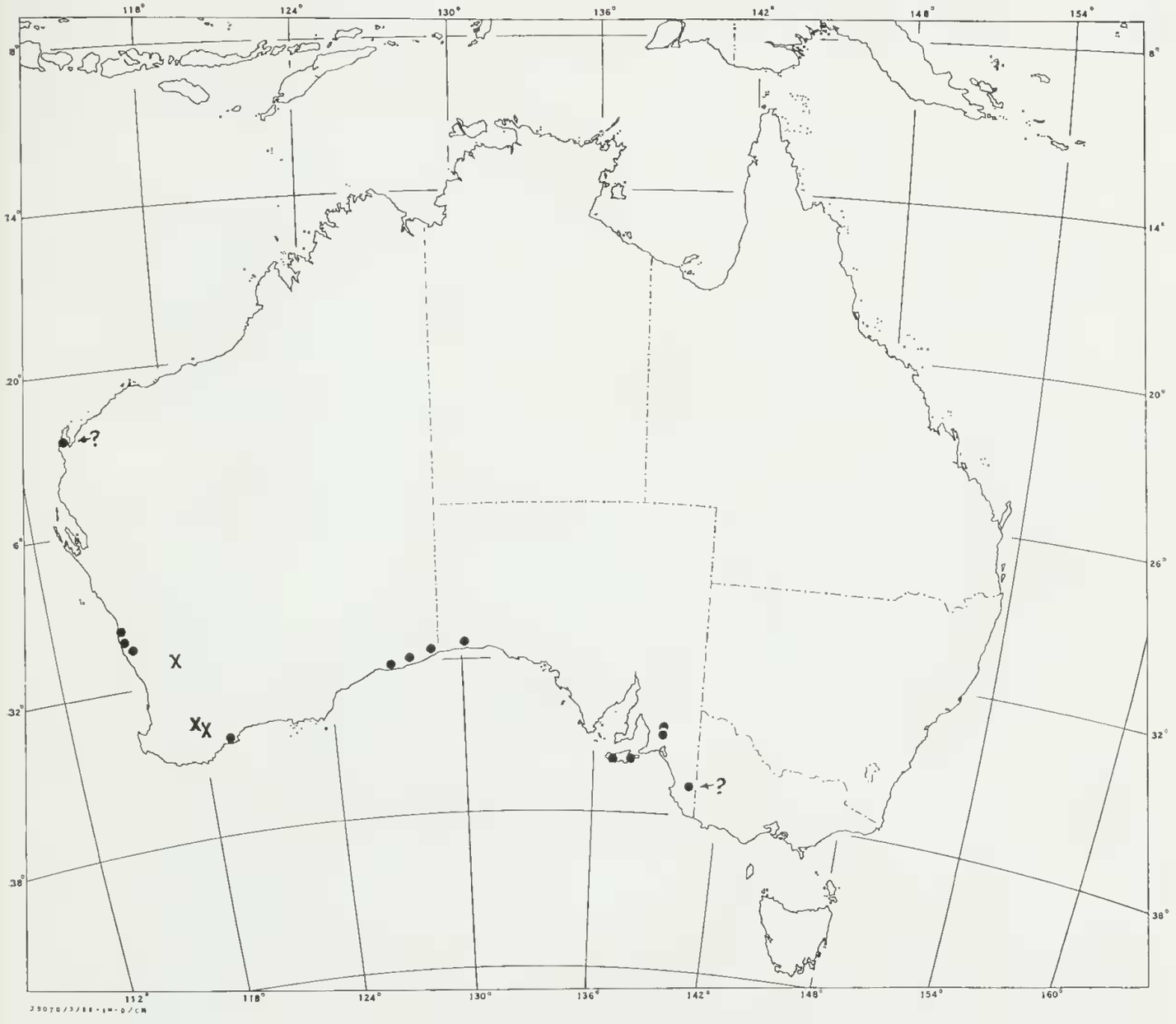

Figure 2.—Occurrences of *Potorous platyops* in geologically Recent (including historic) time.

X Historic records
● Prehistoric

(Few animals have been taken in historic time, and for many of these, locality records are vague. Thus historic localities other than those shown may be involved. The prehistoric locality on North West Cape is queried because it is based only on one molar tooth, and that near Naracoorte, South Australia, because it may represent a time earlier than Recent.)

There are no specimens of *Potorous platyops* in the Western Australian Museum collection of modern mammals, but the collection of fossil mammals contains fragmentary remains from Bremer Bay (discussed herein), and from several caves in the Moore River-Dongara coastal region (61.7.32, 62.1.15, 64.10.35, 68.2.25-26 from Hastings Cave, 65.12.422-423, 70.6.66, 70.6.77 from Wedge's Cave, 69.5.12 from Smithy's Cave, and 70.4.203 from Weelawadji Cave). A single lower molar tooth (68.7.102) from a cave in North West Cape also appears to represent *P. platyops;* this record represents a great extension of the known range of the species, and because it is based only on an isolated tooth, is queried on the distribution map (Fig. 2). The geological age of these specimens is not known, but all come from surface litter or shallow excavations, and are likely to be of late Quaternary if not late Recent age.

Lundelius (1957, 1960, 1963) records fossil specimens, probably of Recent age, in Hastings and Wedge's Caves in the Moore River-Dongara region, and also from Webbs Cave in the south central Nullarbor region. Neither the South Australian Museum (N.S. Pledge, personal communication) nor the Western Australian Museum collections of fossil mammals contains any specimen of *P. platyops* from the Nullarbor region. However, small numbers of *P. platyops* specimens have been found in cave deposits near Madura, Eucla and Koonalda, southern Nullarbor region, excavated by the Australian Institute of Aboriginal Studies Nullarbor Plains Archaeological Survey; all appear to be of late Recent age (P. Thompson, personal communication).

Finlayson (1938) based a separate species *Potorous morgani* on bony remains of two animals from a cave in the south west of Kangaroo Island, South Australia. This species is now generally included in *Potorous platyops* (e.g. Ride 1970). Finlayson's specimens have been examined by one of us (D.M.) and found closely to resemble the Western Australian Museum fossil specimens listed above, ascribed to *P. platyops*. Other specimens, representing up to seven individuals, have been found in surface litter in a cave near the type locality of *P. morgani* (P. F. Aitken and C. R. Tidemann, personal communications), and Finlayson (1959) records the finding of another specimen in the south east of Kangaroo Island.

Hale and Tindale (1930) record *Potorous* remains from three levels in an archaeological excavation at Devon Downs, on the bank of the lower Murray River, and Finlayson (1959) records these specimens as *P. morgani*. In archaeological excavations in Shelter 2 at the nearby Fromm's Landing site, two levels yielded remains of *P. morgani* (Wakefield, in Mulvaney, Lawton and Twidale 1964). Remains of several individuals attributed to *P. morgani* have been found recently in an excavation in Victoria Cave in the Naracoorte district, South Australia (M. J Smith and R. T. Wells, personal communication).

Thus, the species appears to have been wide ranging but not abundant. There appears to have been no record of it alive for nearly a century (Ride 1970), and it may be extinct. The Bremer Bay specimens (70.3.21, 70.3.43-46, 70.4.4-5, 70.4.11, 70.4.19, 70.4.55, 70.4.66-88, 70.4.134 and 70.4.177) are fragmentary and represent only a few animals (probably about five), but even so are a welcome addition to the few known remains of *Potorous platyops*.

The Western Australian specimens cited above, which include tooth-bearing fragments of skulls and mandibles and some post-cranial elements, show that in these respects *Potorous platyops* closely resembled Gilbert's potoroo (*Potorous tridactylus* from the extreme south west of Western Australia) except in being considerably smaller. Thus *Potorous platyops* femur 70.4.68 has a length of about 55 mm, whereas *P. tridactylus* femur 65.6.73, of comparable stage of growth, is 68 mm long. For comparison, rabbit femur M 6935 is 78 mm long. The length of the lower cheek tooth row in adult *P. platyops* is about 15 mm (14.3 mm in 70.4.134, 15.3 mm in 70.4.66) whereas the lower cheek tooth row is about 21 mm long (20.5 mm in 65.9.49) in adult *P. tridactylus*. The length of the lower permanent premolar in *P. platyops* ranges from 3.5 to 4.1 mm in 9 measurable specimens (including one of *P. morgani* from Kangaroo Island) and the width from 1.4 to 2.1 mm in the same specimens; the lower permanent premolar in *P. tridactylus* specimen 65.9.49 is 5.2 x 2.6 mm.

Interpretation of the site

The preponderance of murids, the scarcity of animals larger than rabbit size, the preponderance of mammals over other vertebrates, the predominantly unbroken character of individual bones, and the occurrence of local concentrations of bone all point to a large night-hunting predatory bird as being responsible for the bone concentrations. The Barking Owl (*Ninox connivens*) or the Masked Owl (*Tyto novaehollandiae*) appear to be the species most likely involved. We suggest that each of the local bone concentrations described above represents the feeding place of a Barking or Masked Owl.

These owls normally kill their prey at first attack, transport the body to a feeding site, and either swallow very small animals whole or tear off lumps of meat and open the body cavity and then swallow larger mammals (of about the size of a rat). The carcases remain in the modified upper portion of the alimentary canal during digestion of soft tissues. The remaining hair, bone and other indigestible tissue from each meal is worked by muscular contractions into a compact, coherent pellet which is then regurgitated. Breakdown of such pellets and removal of hair by insect and other scavengers, and physical weathering, would then leave just such bone concentrations as we found.

An owl pellet origin satisfactorily accounts for almost all the smaller animals, not only mammals, but also the very small numbers (about 25) of small birds, lizards and frogs represented. However, such an origin for animals as large as a dog or sheep, or as well armed as an adult *Dasyurus*, is most improbable, unless they represent carrion. Nor can fish, large or small, reasonably be ascribed to the activities of owls. We suggest that the basic owl pellet deposit has been overlaid at various times by other bone from various sources. Fox droppings with chewed bone (e.g. 70.4.167) would decay to leave fragmented remains of large as well as small vertebrates, and other carnivores such as *Sarcophilus* might also be involved in this way. Fish remains could result from scavenging by foxes on the beach nearby, or perhaps more likely, scavenging by birds such as ravens, ospreys, or whistling eagles (all of which were observed during our visit, carrying fish in the first two cases). Remains of sheep might well be due to animals dying naturally on the site; *Macropus irma* specimen 70.3.28, consisting of most of the bones of a single animal found in close association, almost certainly represents such a natural death.

It is most unlikely that the 200 x 250 m zone of bone concentration would attract owls to roost in its present state, completely devoid of living plants, and almost devoid of perching places above the ground. But there are areas a few hundred metres further inland which might attract owls. Such an area is shown in Fig. 3, in which "islands" of living trees and shrubs occur among the mobile dunes, distant only a few hundred metres from continuously vegetated areas. It is conceivable that owls would hunt in the vegetated areas, but take their prey to an "island" of vegetation from which the approach of enemies would be readily visible.

We suggest, then, that at the time of accumulation of the bones, each site of local bone concentration within the 200 x 250 m bone-rich

Figure 3.—Stands of living peppermint trees and shrubs isolated among mobile sand dunes, Bremer Bay. Such stands, if not too far from continuously vegetated areas of profitable hunting, conceivably could serve as owl roosts.

zone was an isolated clump or "island" of vegetation somewhat resembling those shown in Fig. 3, in an area in which the general plant cover had already begun to deteriorate, and the sandy soil to shift. In such a deteriorating area, owl pellets might be buried before they disintegrated, thus protecting the enclosed bones from direct exposure to the weather, which would have resulted in a more cracked and split appearance than they have in fact.

Age of the deposit

Radiocarbon dates on wood from the fallen peppermint tree shown in Fig. 1 and on murid bones and teeth from the main bone accumulation near this tree have been obtained. They are 620 ± 90 years B.P. on the wood (GaK-2888) and 1190 ± 80 years B.P. on the bones and teeth (GaK-2887).

Discussion

The 250 x 200 m bone rich zone mentioned above is now completely devoid of living vegetation, but presumably at the time of accumulation (about A.D. 760) supported clumps of trees like those shown in Fig. 3, if not more continuous vegetation. Nearly six centuries later (about A.D. 1330) it still supported at least one large peppermint tree, very much larger than those shown in Fig. 3. At the present time, isolated clumps of peppermint trees still grow a few hundred metres away, within the same complex of mobile dunes. Thus it would appear that devegetation of the dune area by (or accompanying) drifting sand has been a very slow process, still not complete after more than a thousand years.

Early in this history of slow devegetation, it would appear that one or more owls inhabited the area. Assuming that a single owl catches mammals of about rat size at an average rate of one mammal per night, the total bone collection made by us represents only about two years' residence by one owl.

The native mammal species listed above fit the concept of their having been drawn by an owl from a territory consisting partly of heath, partly of gallery forest on the banks of a stream, as the area is now, and under a similar climate. Similar associations of species are known from other deposits of Recent geological age currently under study.

For example, in Hastings Cave in the Jurien Bay district, all four murid species listed above (and others) occur with the marsupial species *A. apicalis, S. murina, I. obesulus, Perameles* cf. *P. bougainville, P. platyops* and others (A. Baynes, personal communication). In an archaeological deposit in the Wanneroo district known informally as Orchestra Shell Cave, *A. apicalis, A. flavipes* and *S. murina* occur together with other marsupial and eutherian species (M. Archer, personal communication).

Similar associations of species are also known from historic time. For example, in the Cheyne Beach district, in which *A. apicalis* was recently found still to persist (Ride 1970), *A. flavipes* and *S. murina* also have been found living. According to Glauert (1950), the collector George Masters obtained specimens of *Perameles myosurus* (now generally regarded as conspecific with *P. bougainville,* e.g. by Ride 1970) as well as *Perameles obesula* (now generally known as *Isoodon obesulus*), along with *Hypsiprymnus platyops* (= *Potorous platyops*), *Antechinus apicalis* and other marsupial species in the King George's Sound-Pallinup (Salt) River region in 1868-69.

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